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LIVILLA VARIEGATA (LÖW) (HEMIPTERA: STERNORRHYNCHA: PSYLLIDAE) NEW TO NORTH AMERICA, WITH RECORDS OF THREE OTHER PALEARCTIC PSYLLIDS NEW TO NEWFOUNDLAND

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Abstract.—*Livilla variegata* (Löw) is reported from Newfoundland as the first North American record of this European psyllid. Adults were collected from *Laburnum* spp. (Fabaceae) in and near St. John's in July 2004. The psyllid is assumed to have been introduced with the shipment of ornamental laburnums from Europe. A taxonomic diagnosis and description are provided to facilitate its recognition in the Nearctic fauna. We also give the first records from Newfoundland of the Palearctic psyllids *Psylla buxi* (L.) (new Canadian record), *Cacopsylla mali* (Schmidberger), and *C. peregrina* (Förster).

Key Words: insect detection, nonindigenous species, *Cacopsylla mali, Cacopsylla peregrina, Psylla buxi,* new records, *Laburnum*

Alien insects continue to enter North America and become established in our fauna. Only a small proportion of non-native species should be considered invasive—that is, capable of dominating ecosystems, causing economic or environmental damage, or impairing human health. Non-native insects (and mites), however, are estimated to cause 40–50% of all crop losses in the United States (Sailer 1983). It is desirable to document the establishment of all exotic insects in North America, regardless of their presumed economic, environmental, or medical importance. Since 1993, we have emphasized the detection of exotic insects in the Atlantic Provinces of Canada.

On a recent trip to Newfoundland, we collected the European psyllid *Livilla variegata* (Löw), which is reported here as new to North America. We also give records from Newfoundland of the Palearctic psyllid *Psylla buxi* (L.) as the first for Canada and record two other Palearctic psyllids, *Cacopsylla mali* (Schmidberger) and *C. peregrina* (Förster), as new to Newfoundland.

Livilla variegata (Löw)

Livilla Curtis, a western Palearctic genus, comprises 43 species that are found mainly in the Mediterranean basin and feed only on genistoid legumes (Fabaceae), such as species of *Chamaecytisus, Cytisus,* and *Genista* (Percy 2002).

Livilla variegata was described in the genus *Floria* from Bosnia and Herzegovina (as Yugoslavia) (Löw 1881); *F. alpina* Cerutti is considered a synonym (Burckhardt 1983). The psyllid also is known in Europe from Austria, Czech Republic, France, Germany, Hungary, Italy, Romania, Slovakia, Spain, Switzerland, and United Kingdom (England, Scotland, Wales) (Hodkinson and Hollis 1987, Lauterer and Malenovský

2002, Percy 2003, Malenovský and Kment 2004). It is a relatively recent addition to the British fauna, apparently having been introduced unintentionally with nursery stock (Hollis 1978, Hodkinson and Hollis 1980), and was detected recently in Austria, Czech Republic, Germany, Hungary, and Slovakia (Lauterer and Malenovský 2002, Malenovský and Kment 2004). An apparent northward spread in Switzerland since the 1970s has been attributed to climatic changes (global warming) (Burckhardt and Mühlethaler 2003). Its apparently recent establishment elsewhere in Central Europe also might be due to global warming (D. Burckhardt, personal communication).

Except for an association with golden chain, *Laburnum* species (Hollis 1978; Hodkinson and Hollis 1980, 1987; White and Hodkinson 1982; Burckhardt 1983; Burckhardt and Mühlethaler 2003; Malenovský and Kment 2004), little is known about the life history and habits of *L. variegata.* In Italy, nymphs are found in April and May and adults from April to August; populations are thought to be univoltine, with either eggs or early instars overwintering (Lauterer and Malenovský 2002, Malenovský and Kment 2004). White and Hodkinson (1982) briefly described the fifth instar, and Maryańska-Nadachowska et al. (1994) reported on the chromosomal length and karyotype.

Diagnosis.—*Livilla variegata* is a member of the subfamily Arytaininae, which also includes the Old World legume-feeding genera *Arytaina* Förster and *Arytainilla* Loginova. Both genera include a species that has been accidentally introduced into North America [i.e., *Arytaina genistae* (Latreille) and *Arytainilla spartiophila* (Förster)] (Pfeiffer 1986, Wheeler and Hoebeke 2004a). *Livilla variegata* can be readily separated from *Arytainilla spartiophila* by the large genal cones that are at least as long as the vertex along the midline (genal cones in *A. spartiophila* at most 0.25 times the length of the vertex). Also, the forewing of *L. variegata* is oblong oval, broadest in the apical third, yellowish, and without a distinct pattern but often with the apical portion suffused with gray to pale yellowish brown (wing of similar shape in *A. spartiophila* but entirely pale yellow throughout). From *Arytaina genistae, L. variegata* is differentiated by the oblong-oval forewing (forewing elliptical and broadest at or before middle in *A. genistae*), which lacks a distinct pattern (in *A. genistae,* the apical cells of the forewing with distinct, longitudinal dark brown to black pattern; Wheeler and Hoebeke, 2004a: 178, fig. 1). Furthermore, *Arytaina genistae* and *Arytainilla spartiophila* feed on *Cytisus scoparius* (L.) Link, Scotch broom, whereas *L. variegata* is known only from *Laburnum* species.

Description of adult (Fig. 1).—The following description is taken from Hodkinson and Hollis (1987): *Coloration:* Mature specimens with dorsum of head and thorax orange yellow with paler longitudinal markings; genal cones orange yellow; abdominal sclerites dark brown, intersegmental membranes yellow; genitalia orange yellow; forewing membrane clear to pale yellow basally, apical suffusion gray to pale yellowish brown, veins pale yellow to pale brown; antenna dirty yellow, apices of flagellomeres 1–4 and whole of flagellomeres 5–8 dark brown; legs dirty yellow. *Structure:* Head with genal cones slender, slightly longer than vertex, with narrowly rounded apices. Forewing length: male (2.76–3.06 mm), female (2.82–3.59 mm). Forewing oblong oval; costal break and rudimentary pterostigma present; veins delicate; dense fine spicules throughout all cells; vein Rs weakly curved to margin; vein M evenly curved; vein M_{1+2} reaching wing apex; cell cu_{1a} strongly arched. Metatibia with 5 thick black apical spurs; basal metatarsus with 1 black spur. Male proctiger, paramere, aedeagus, and female terminalia illustrated by Hodkinson and Hollis (1987:78, 80).

New Nearctic record.—We first collected *L. variegata* on *Laburnum* species on the main campus of Memorial University of

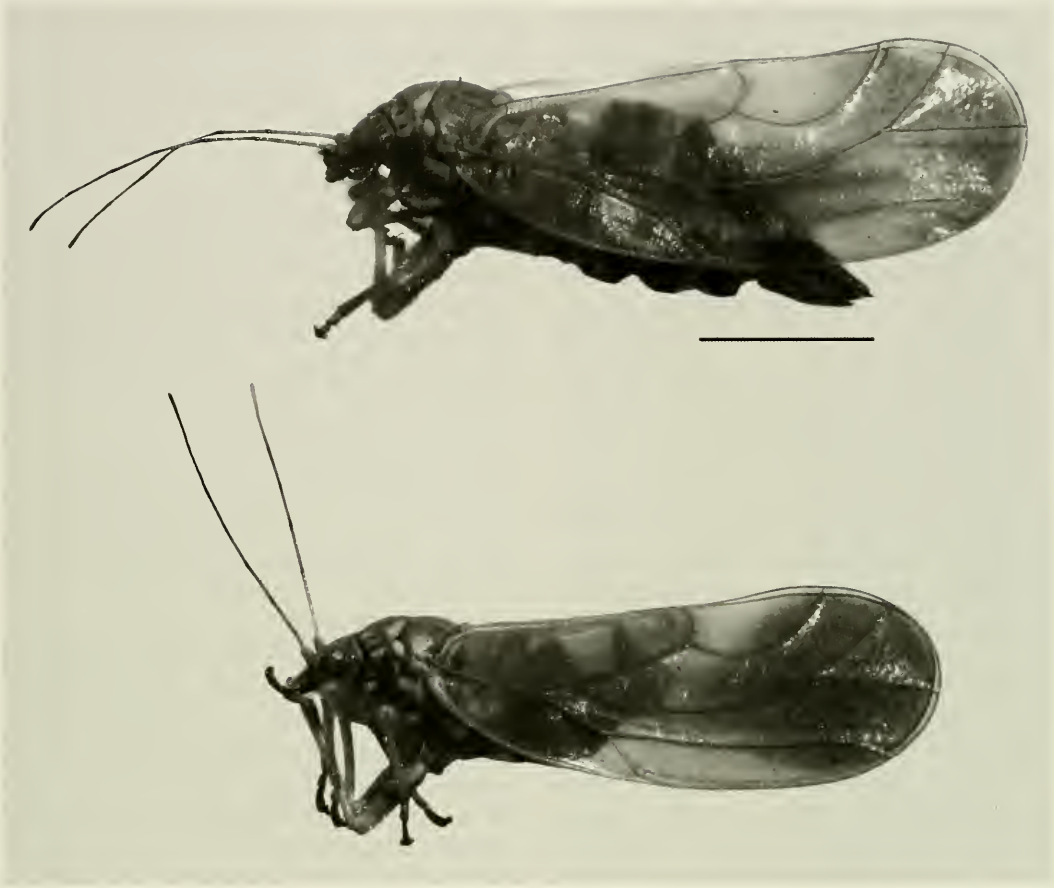

Fig. 1. *Livilla variegata* adult female (above) and male (below), lateral view. Scale line = 1.0 mm.

Newfoundland, St. John's, and later found it on ornamental laburnums at the University's Botanical Garden at St. John's and other nearby localities on the Avalon Peninsula. Adults were found by beating laburnum branches over a shallow insect net. We also observed adults, some of them teneral, mostly on midribs of lower leaf surfaces. Two adults were on laburnum petioles, one was on a petal, and another was on the upper surface of a leaf. Six mating pairs and ten nymphal exuviae were observed on lower leaf surfaces. We did not find nymphs during our collecting (9–14 July 2004).

Material examined.—CANADA: Newfoundland: St. John's, Bannerman Park, 10 July (13 ♀, 9 ♂); Bowring Park, 13 July (18 ♀, 11 ♂); Memorial University of Newfoundland, main campus and Botanical Garden (Mount Scio Rd.), 9–10 July (71 ♀, 40 ♂); South Harbour area, Waterford River Walk, 10 July (11 ♀, 5 ♂); Torbay, Rt. 20, 12 July (23 ♀, 18 ♂).

Voucher specimens of *L. variegata* have been deposited in the Canadian National Collection of Insects, Ottawa, Ont.; Cornell University Insect Collection, Ithaca, NY; and National Museum of Natural History, psyllid collection, Beltsville, MD.

Additional European Psyllidae in Newfoundland

Cacopsylla mali (Schmidberger).—Brittain's (1919) records from Nova Scotia were the first for this Old World psyllid in North America. It also has been recorded in

Canada from New Brunswick (Maw et al. 2000); an apparently overlooked record is Prince Edward Island (USDA 1929b). No published U.S. records are available for *C. mali*, but it is established in the Northeast (A. T. Eaton, personal communication; A.G.W. and E.R.H., personal observations). Our collections from apple (*Malus pumila* P. Mill.) and crabapple (*Malus* spp.) in 2004 are the first for Newfoundland: Carbonear, 11 July (24 ♀, 18 ♂); St. John's, Bowring Park, 13 July (16 ♀, 13 ♂); Memorial University of Newfoundland, 14 July (7 ♀, 10 ♂); Torbay, Rt. 20, 12 July (24 ♀, 26 ♂).

Cacopsylla peregrina (Förster).—A recent addition to the North American fauna, *C. peregrina* previously has been recorded in Canada from British Columbia (Maw et al. 2000) and Nova Scotia (Wheeler and Hoebeke 2004b). U.S. records are limited to California, Oregon, and Washington (Wheeler and Stoops 2001). The first records from Newfoundland are based on our collections from hawthorn, *Crataegus laevigata* (Poir) DC and *C. monogyna* Jacq., in 2004: St. John's, Bowring Park, 13 July (4 ♀, 3 ♂); Harbourside Park, 9 July (14 ♀, 11 ♂); Memorial University of Newfoundland, 14 July (12 ♀, 8 ♂); South Harbour area, Waterford River Walk, 9–10 July (2 teneral adults, 5th instars; not collected).

Psylla (Asphagidella) buxi (L.).—First reported in North America from New York (Riley 1890), *P. buxi* also is recorded from California, Connecticut, Iowa, New Jersey, Ohio, and Oregon in the checklist of Nearctic psylloids (Hodkinson 1988). Additional state records are Delaware (Milliron 1954), Maryland (USDA 1935), North Carolina (David L. Stephan, personal communication), Pennsylvania (USDA 1953), Rhode Island (USDA 1960), Virginia (USDA 1962), and Washington (USDA 1929a).

This pest of ornamental boxwood was not listed from Canada by Maw et al. (2000). Our collections from *Buxus sempervirens* L. in 2004 apparently are the first for Canada: St. John's, Bowring Park, 13 July (13 ♀, 28 ♂); Memorial University of Newfoundland, 14 July (4 ♀, 6 ♂).

Discussion

Livilla variegata is the only species of the genus known from laburnums. The most speciose genistoid legumes (30 or more species) tend to have the greatest number of associated arytainine psyllids (Percy 2002). *Laburnum* is a small genus of only three or four species found in the Mediterranean region and adjacent Asia (Everett 1981).

Like other psyllids that develop on genistoid legumes (Percy 2002, 2003), *L. variegata* tolerates the quinolizidine alkaloids of its hosts. It might sequester alkaloids as a defense against generalist predators, as is known for a laburnum-feeding aphid (Szentesi and Wink 1991).

The shipment and planting of ornamental laburnums beyond their native range appear to be responsible for the addition of *L. variegata* to the British fauna (Hollis 1978, Hodkinson and Hollis 1980, White and Hodkinson 1982). Hodkinson and Hollis (1980) commented that in southern England the introduced *L. variegata* was spreading rapidly and becoming increasingly common, suggesting a considerable period between its establishment and date of first collection (May 1978, in Hayes, Middlesex). When Hollis (1978) first reported it from Britain, records were available not only from additional localities in Middlesex but also from London, Kent, Surrey, Oxfordshire, and Wales.

Evidence points to a similar origin and mode of entry for *L. variegata* in North America: Europe (either the British Isles or the continent) via shipment of laburnum nursery stock. The psyllid belongs to an Old World genus and develops on non-native plants, *Laburnum* spp. Planted as ornamentals in Europe are common golden chain, *L. anagyroides* Medik.; Scotch laburnum, *L. alpinum* (Miller) Bercht. and J. Presl.; and their hybrid, *L. x watereri* (Kirchner) Dippel (as *L. vossii*) (Scheller

1974). Laburnums were introduced into the United States as early as the eighteenth century (Leighton 1976), but they are used less frequently as ornamentals in North America than in Europe (Everett 1981). Laburnums, however, are common in gardens, parks, and yards in St. John's, Newfoundland, where *L. alpinum, L. anagyroides,* and *L.* × *watereri* are planted (Peter Scott, personal communication).

Livilla variegata might have become established many years before we detected it in 2004. The Canadian Psylloidea are poorly known, and only three native species previously have been recorded from Newfoundland (2 spp.) and Labrador (1 sp.) (Maw et al. 2000). Moreover, we did not observe feeding symptoms on foliage, which might attract attention from growers, pest-control specialists, or entomologists.

With the addition of four unintentionally introduced Palearctic species, the majority of Psylloidea known from Newfoundland, excluding Labrador, are adventive (67%). All four species can be added to the extensive list of European insects recorded from the port city of St. John's. European insects in Newfoundland tend to be concentrated on the Avalon Peninsula and often are restricted to the St. John's area (Lindroth 1957). Hamilton and Langor (1987) pointed out that Newfoundland has the world's largest proportion of imported leafhopper species and that St. John's has the largest number of immigrant leafhoppers. A high proportion of immigrant species also characterizes the fauna of certain other insect groups in Newfoundland (e.g., Lindroth 1957, Morris 1983).

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